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Nakamura

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(54) **CONNECTING METHOD, CONNECTING STRUCTURE, CONTACT AND CONNECTOR**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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H01R 12/61	(2011.01)
H01R 12/77	(2011.01)
H01R 13/24	(2006.01)
H01R 12/79	(2011.01)
H01R 107/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H01R 12/592*** (2013.01); ***H01R 12/613*** (2013.01); ***H01R 12/771*** (2013.01); ***H01R 12/79*** (2013.01); ***H01R 13/24*** (2013.01); *H01R 2107/00* (2013.01)

(58) **Field of Classification Search**

CPC H01R 12/592; H01R 13/24; H01R 12/613; H01R 12/771; H01R 12/79

See application file for complete search history.

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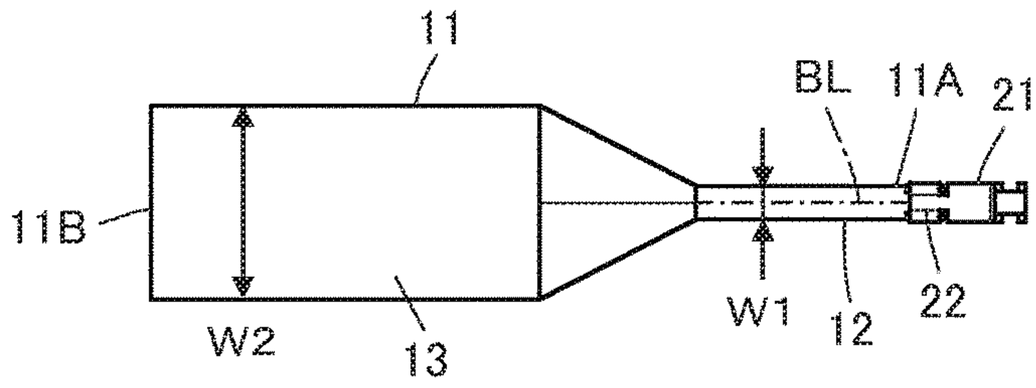
(57) **ABSTRACT**

A first connection portion is formed at an end portion of a flexible conductor by folding the end portion of the flexible conductor in halves along a folding line extending in a given direction, and a contact-side connection portion of a contact presses the first connection portion from opposite sides in a thickness direction of the first connection portion to thereby electrically connect the contact to the flexible conductor.

8 Claims, 10 Drawing Sheets



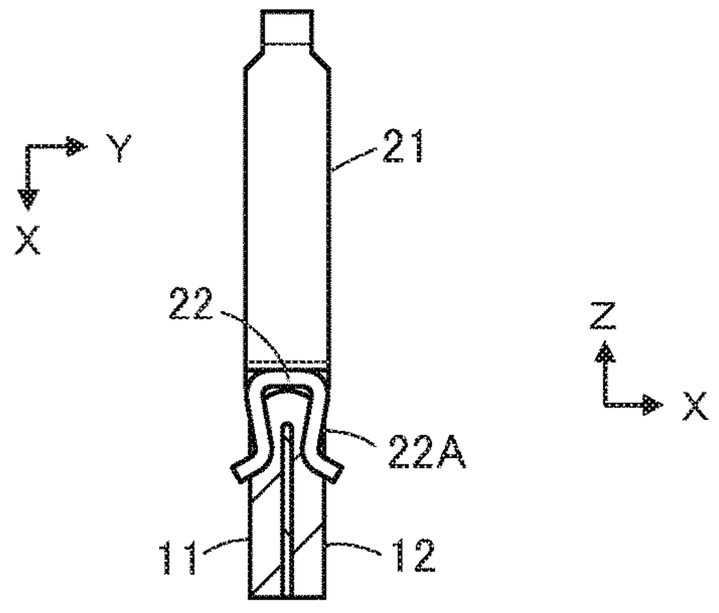


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FIG. 1

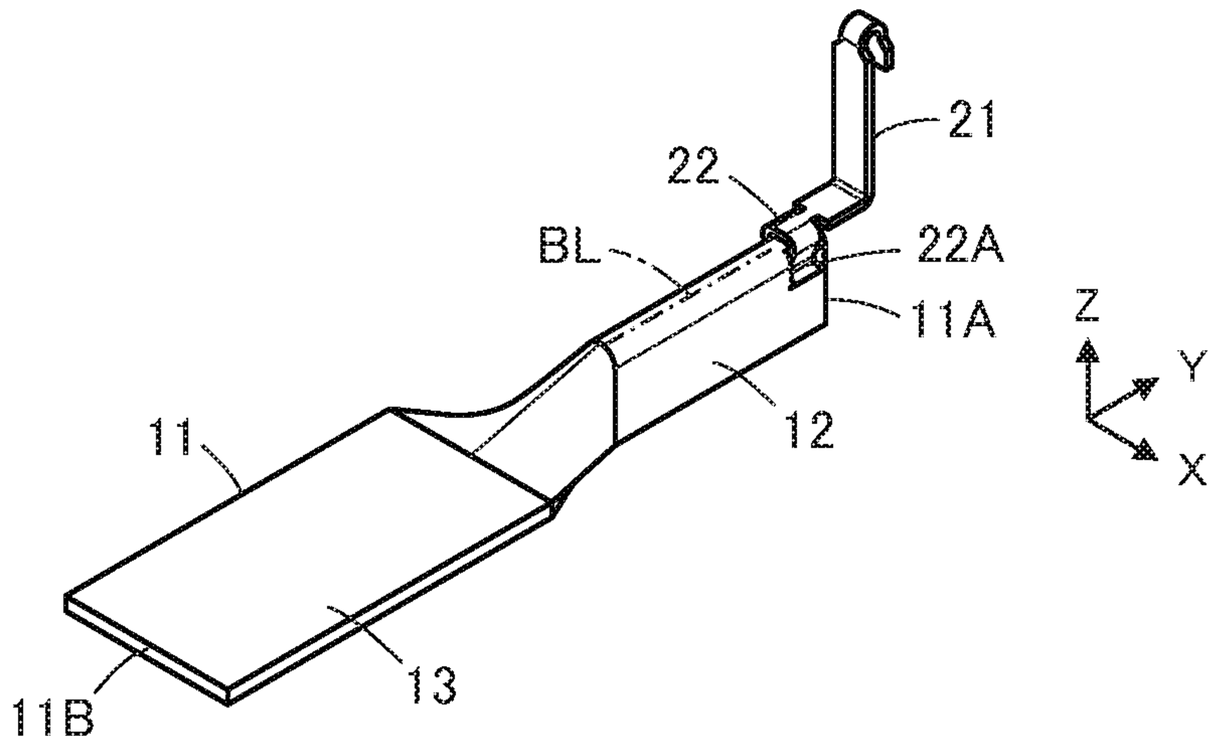


FIG. 2

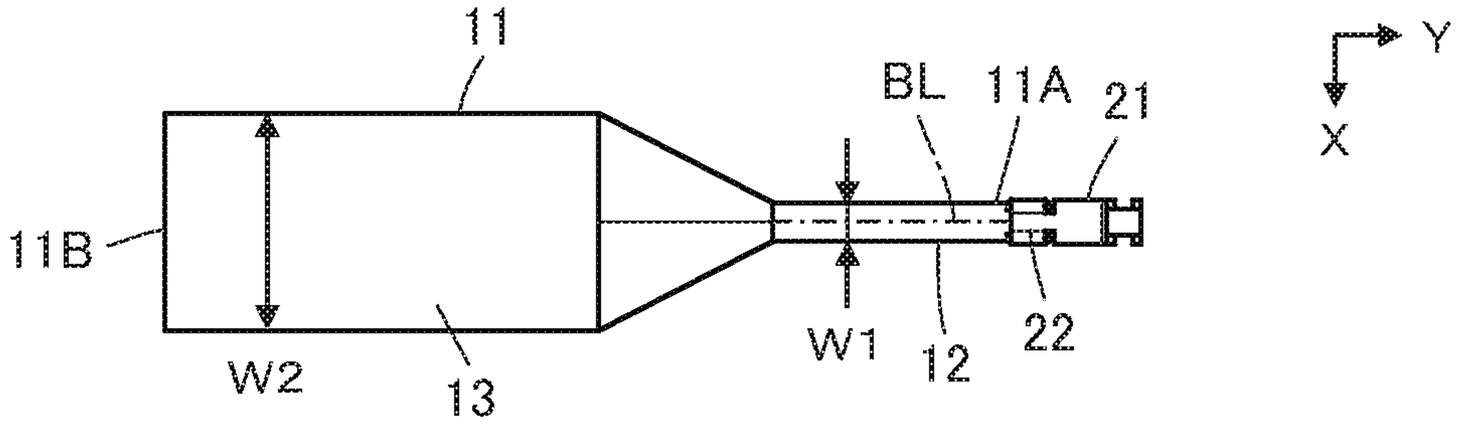


FIG. 3

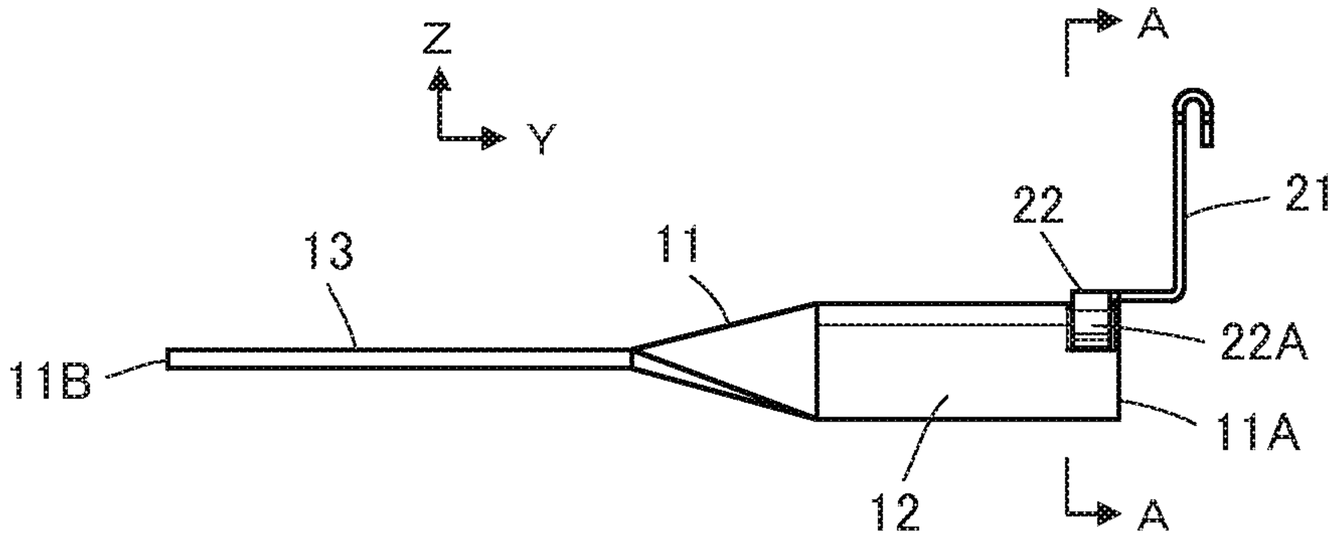


FIG. 4

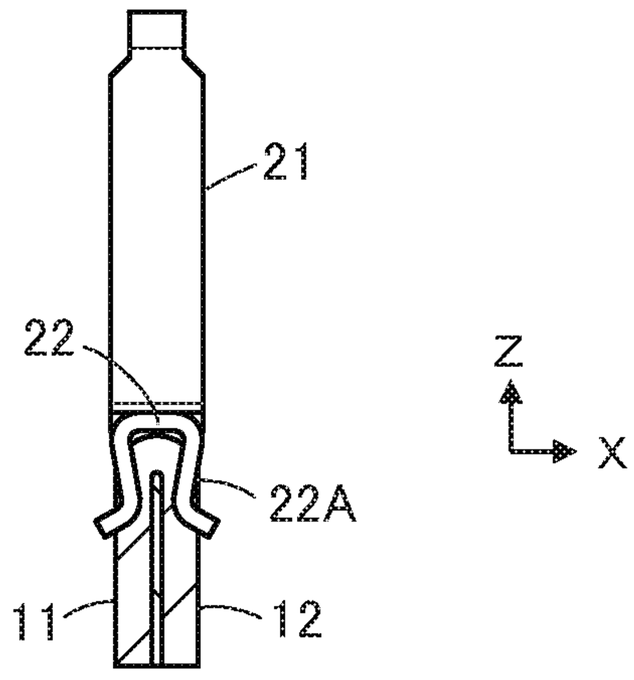


FIG. 5

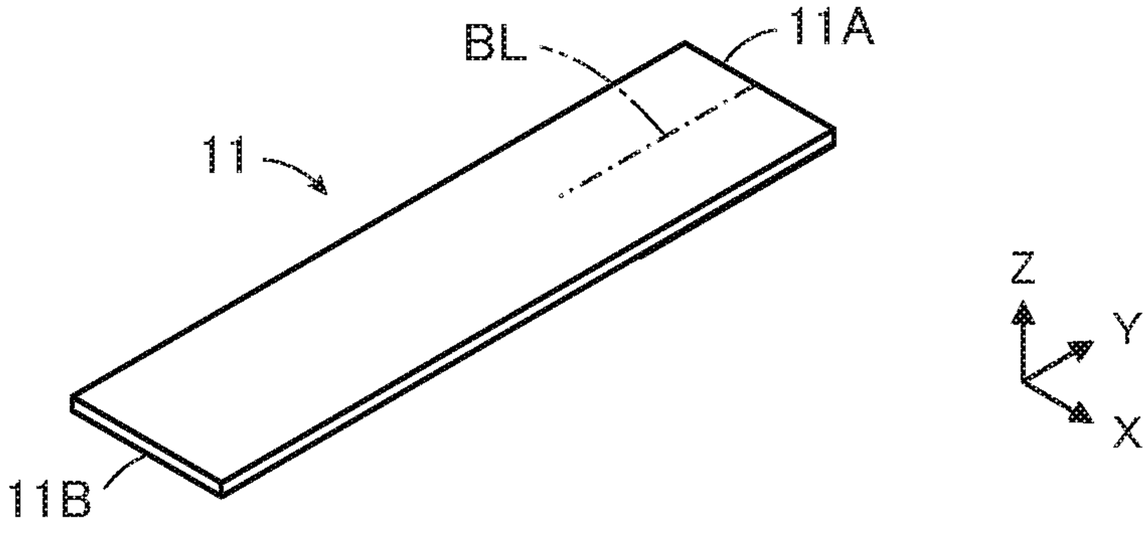


FIG. 6

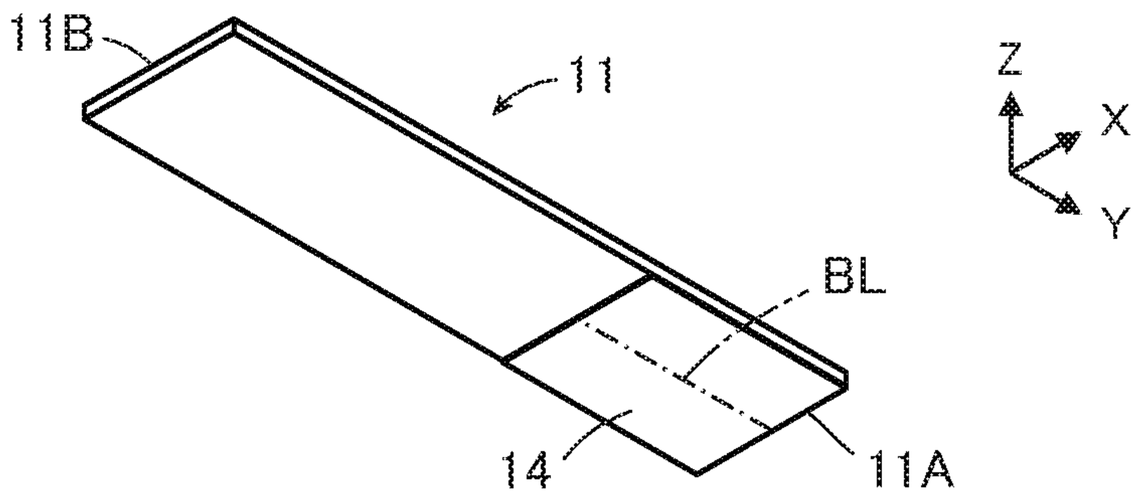


FIG. 7

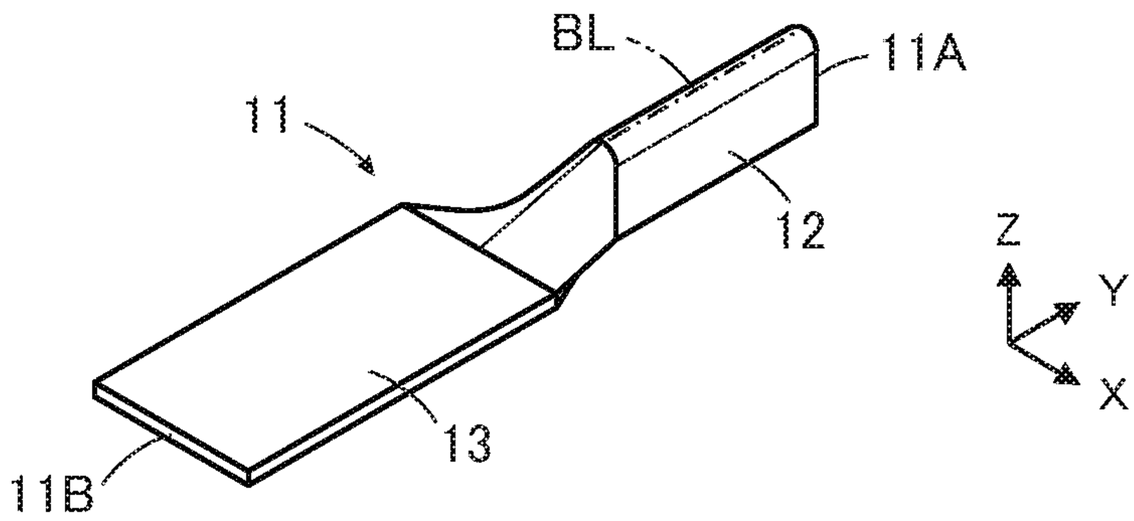
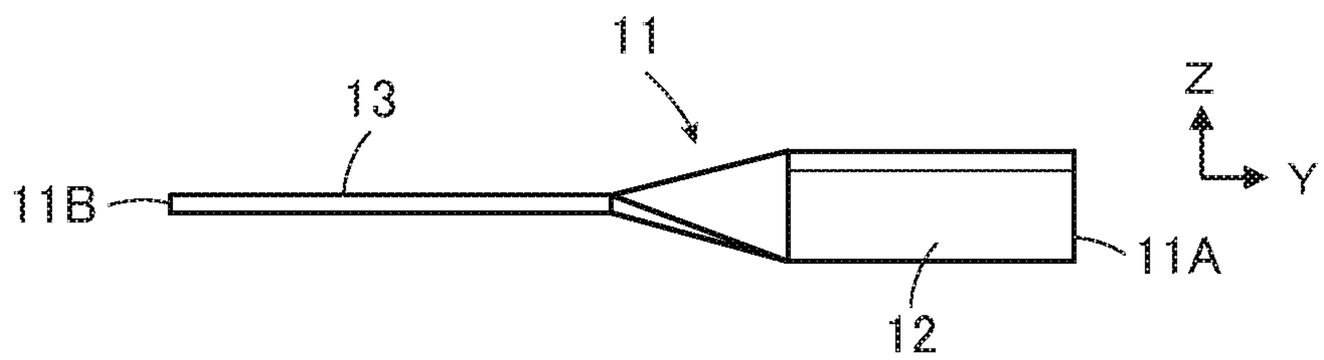


FIG. 8



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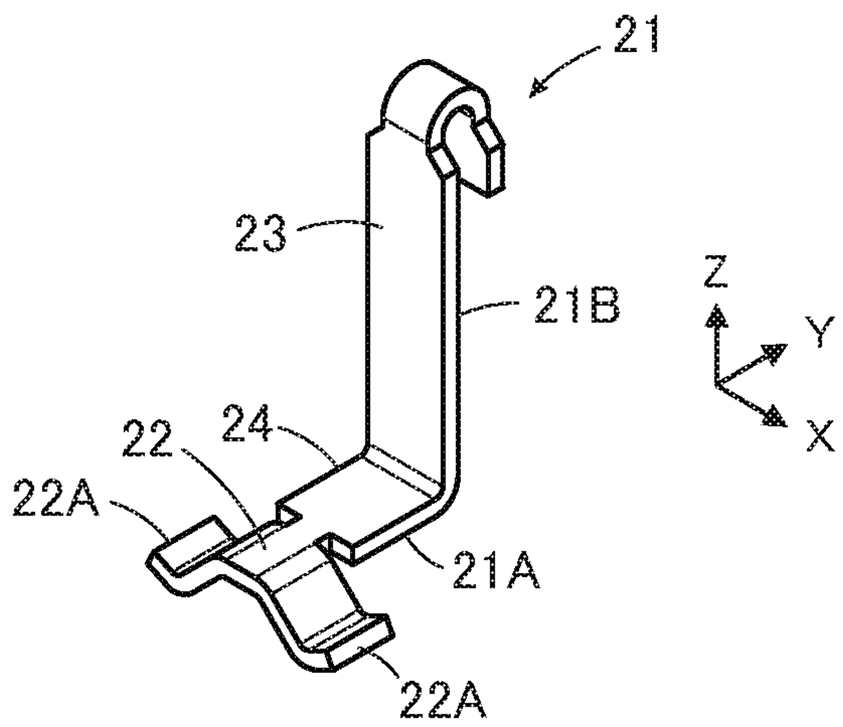


FIG. 10

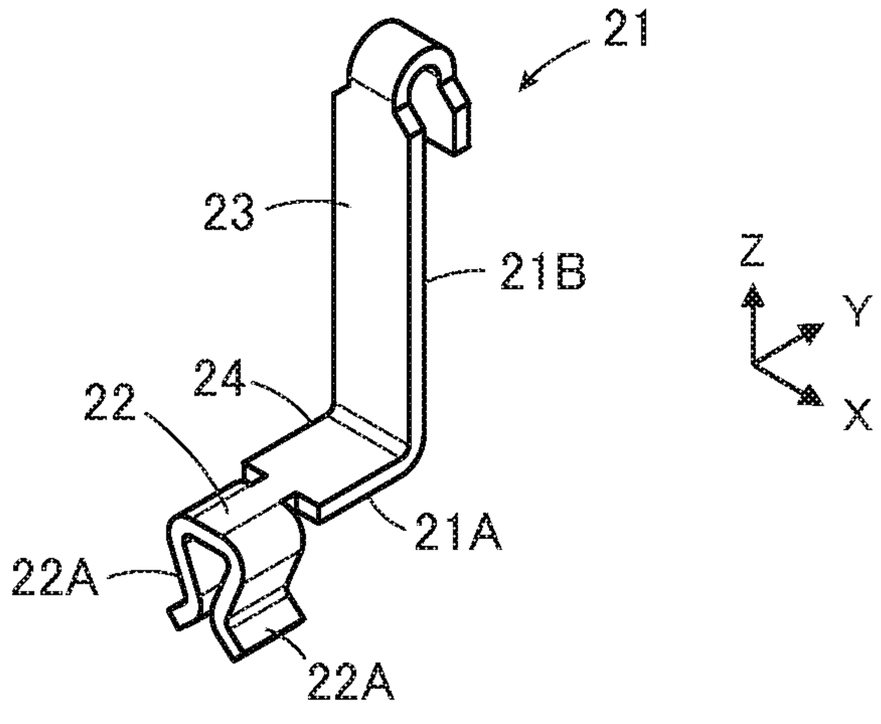


FIG. 11

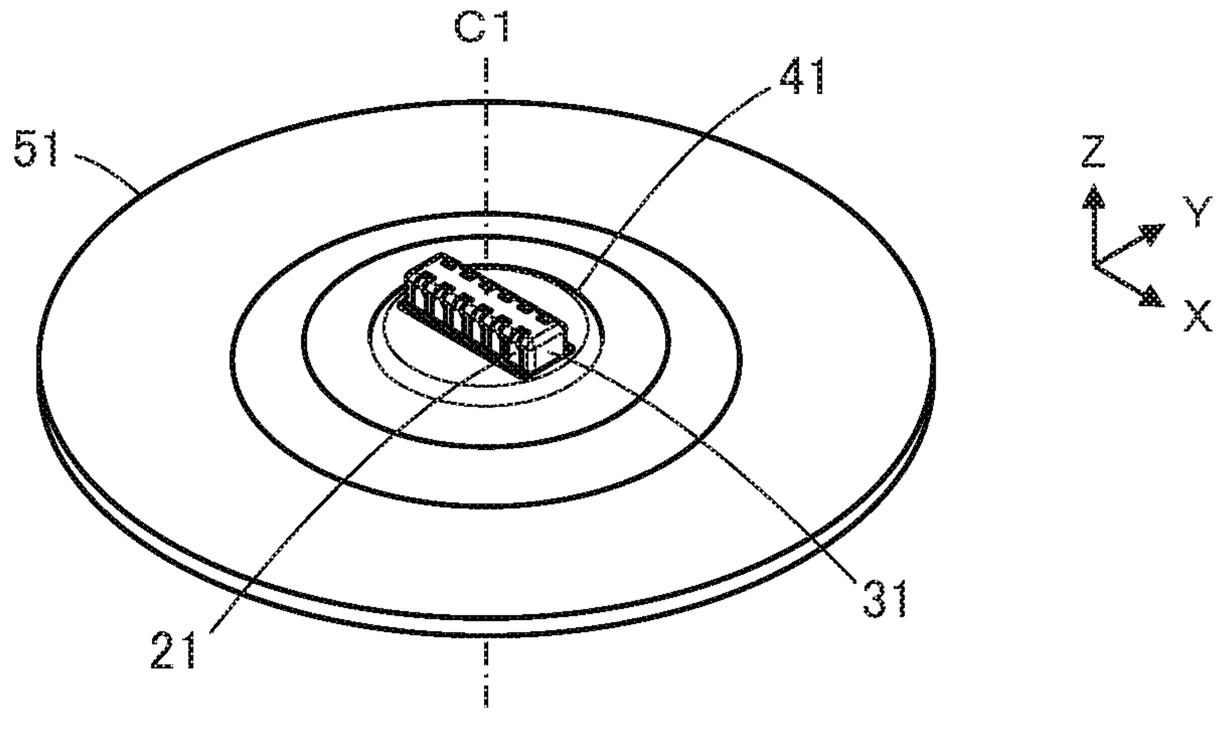


FIG. 12

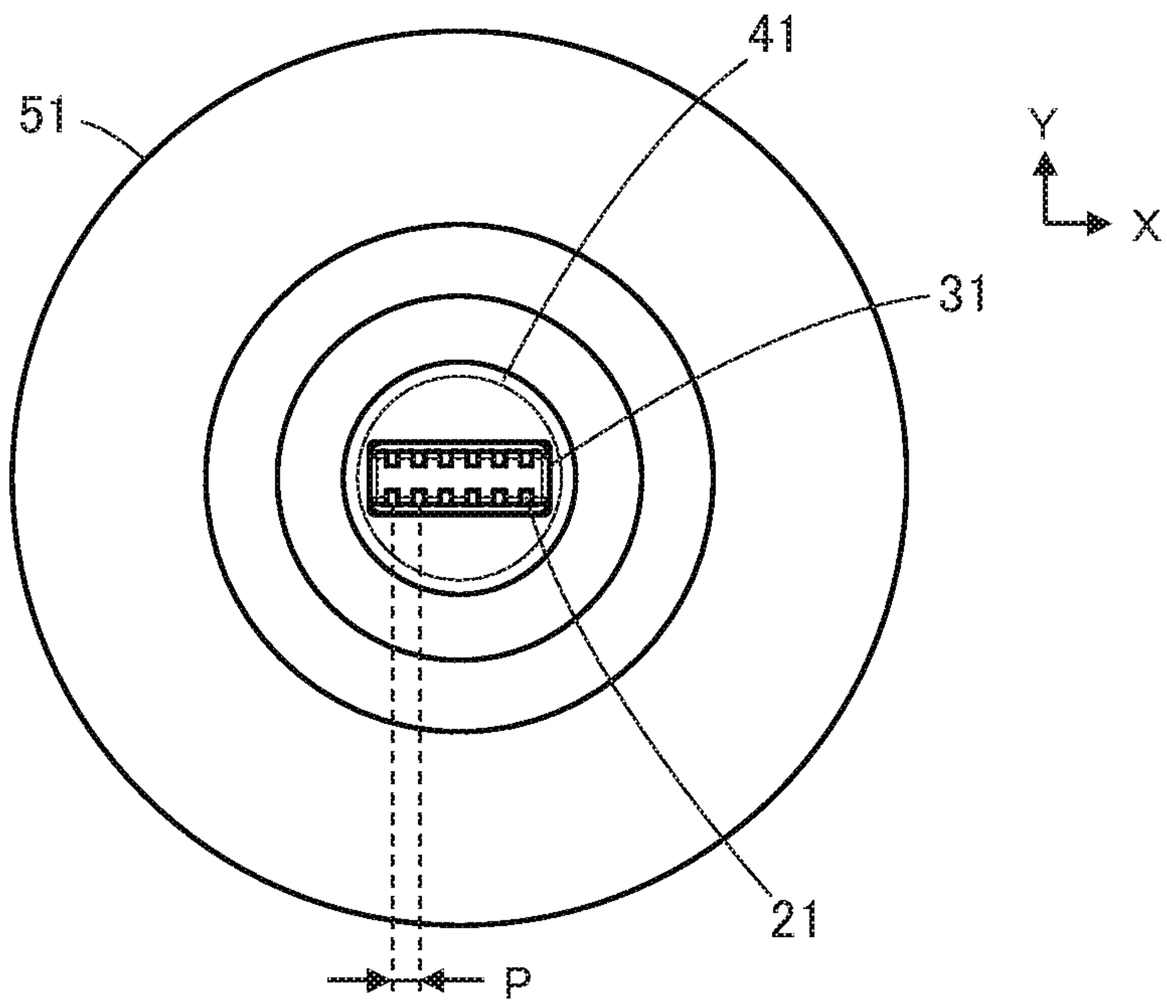


FIG. 13

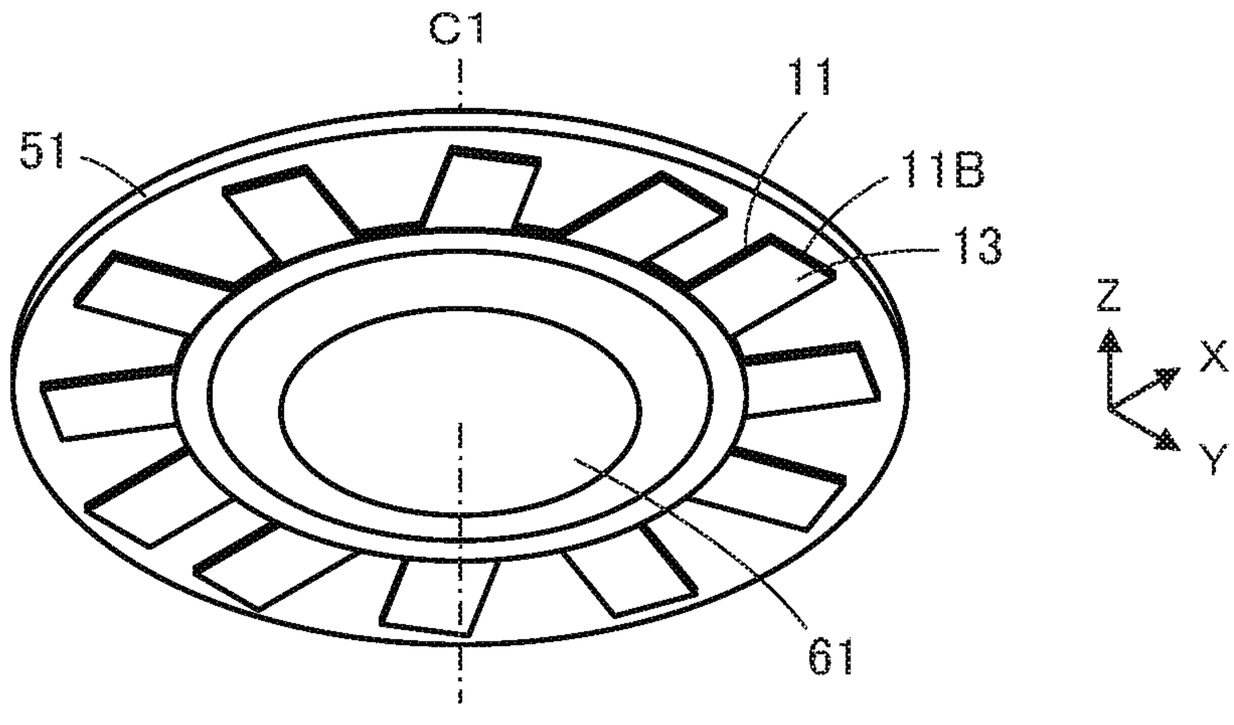


FIG. 14

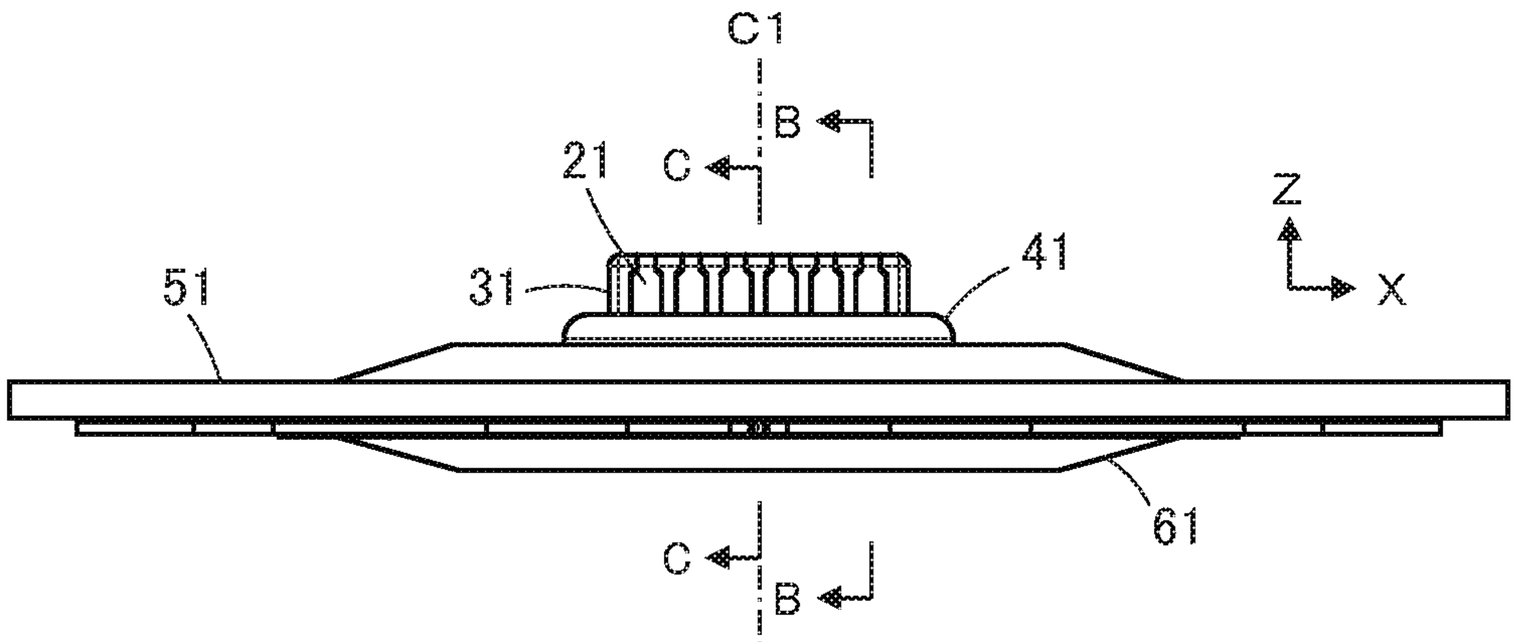


FIG. 15

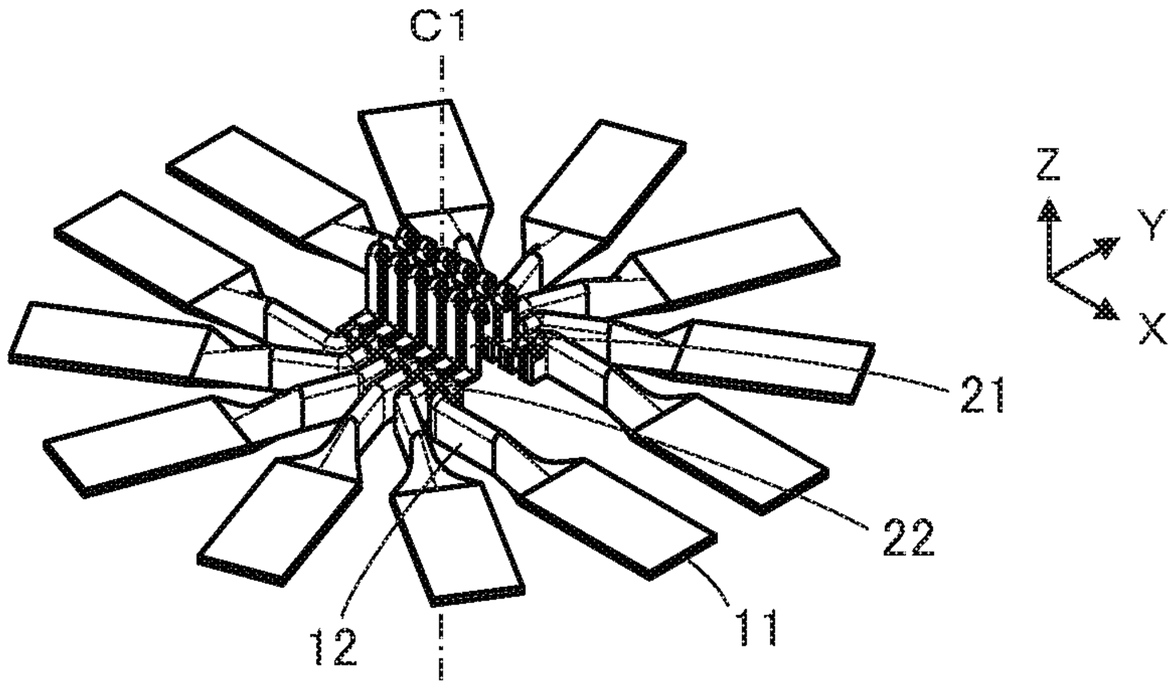
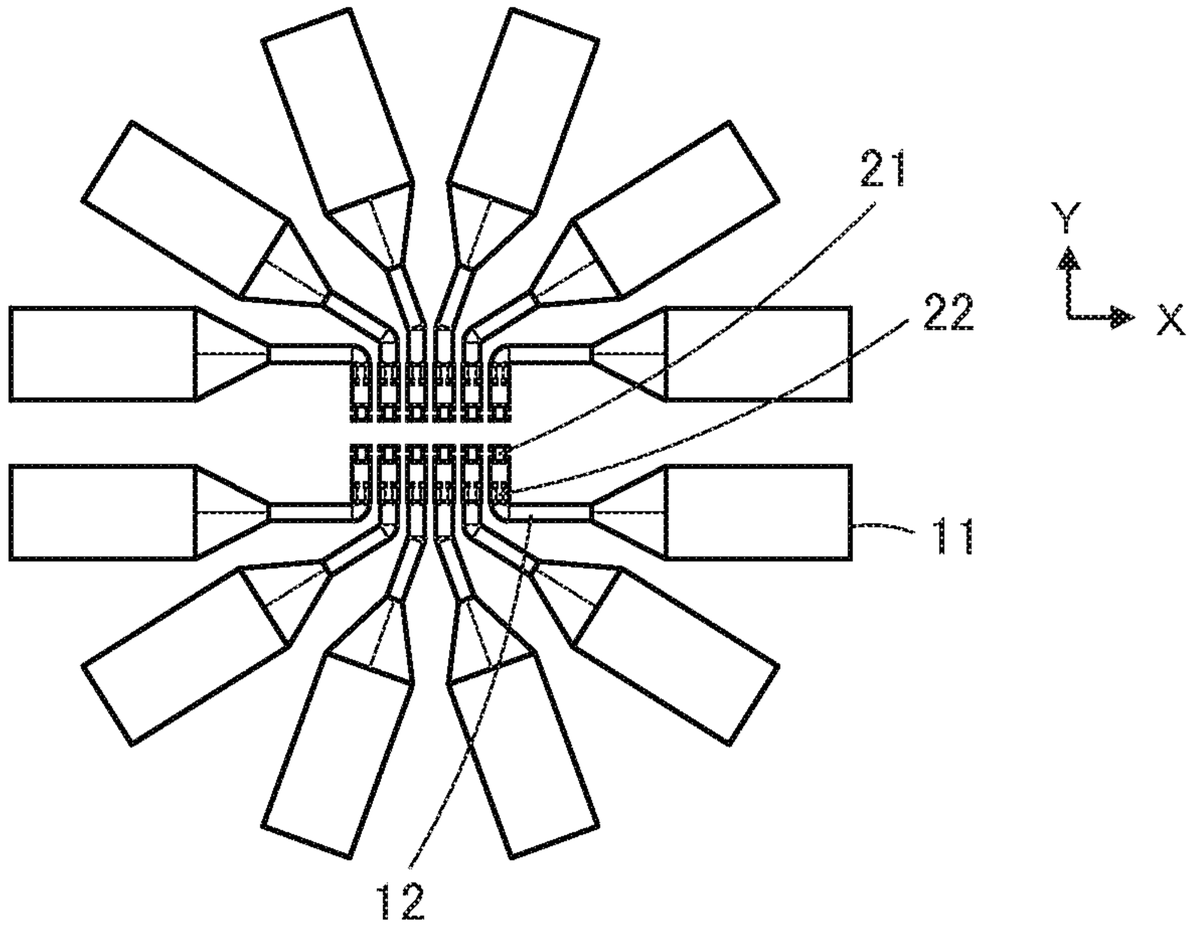


FIG. 16



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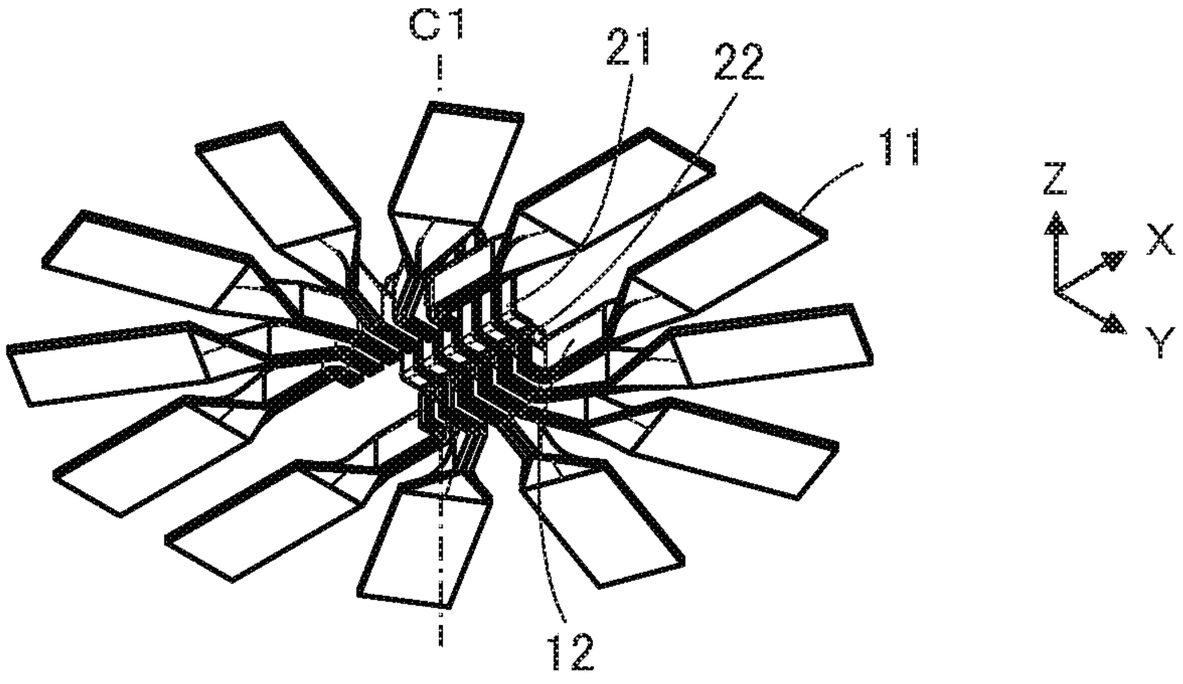


FIG. 18

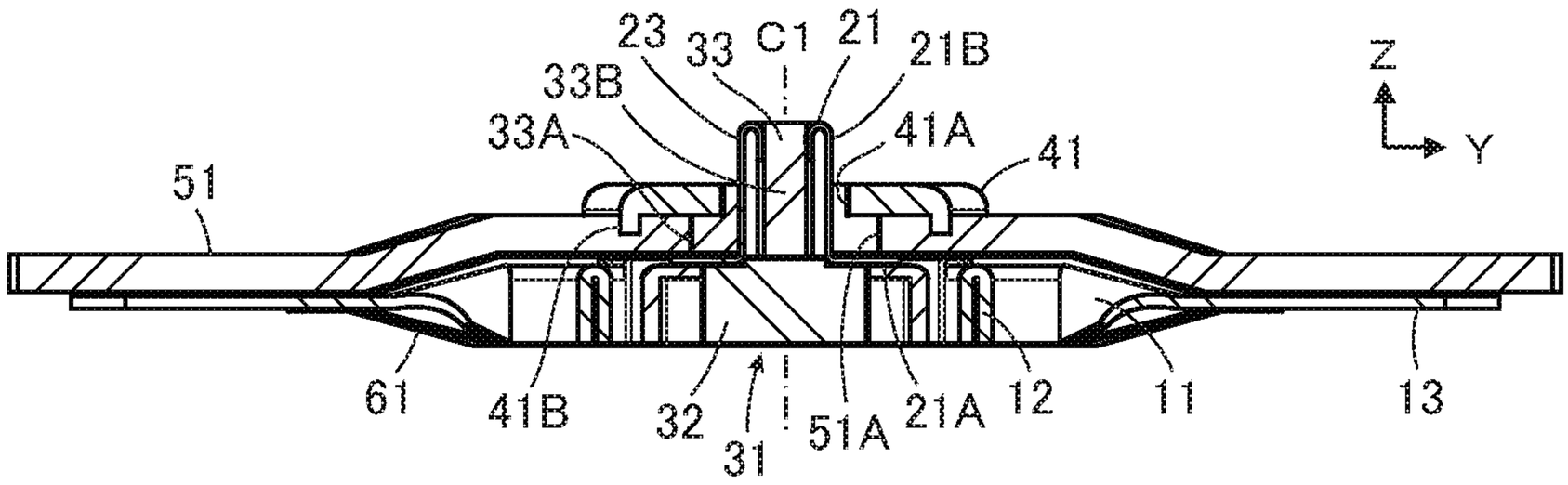
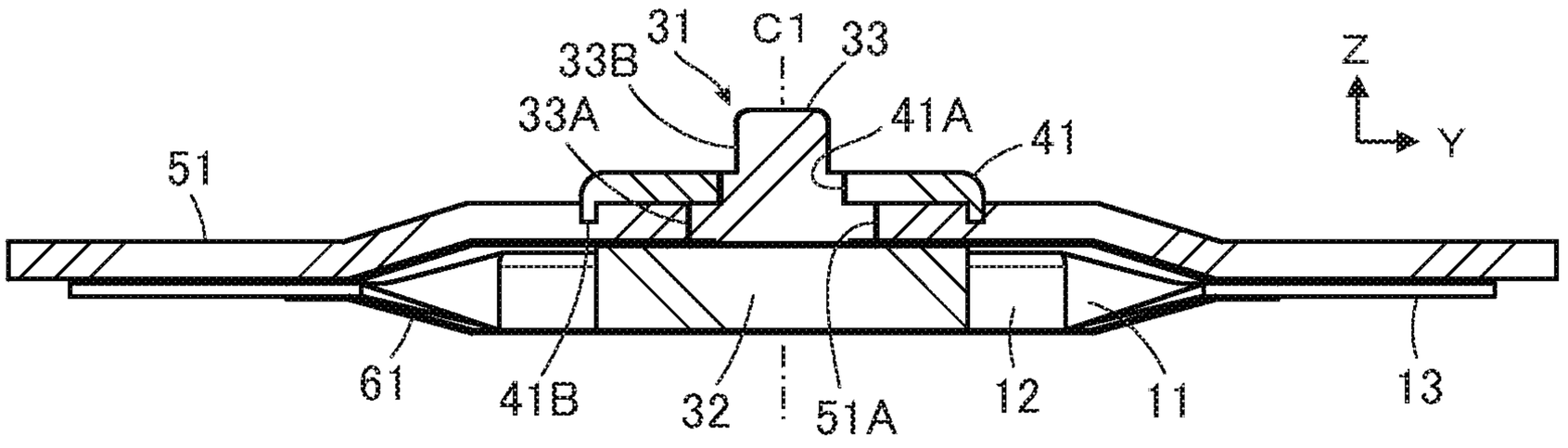


FIG. 19



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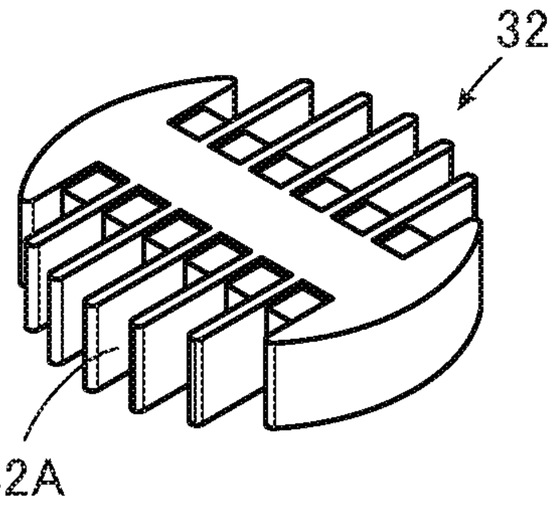

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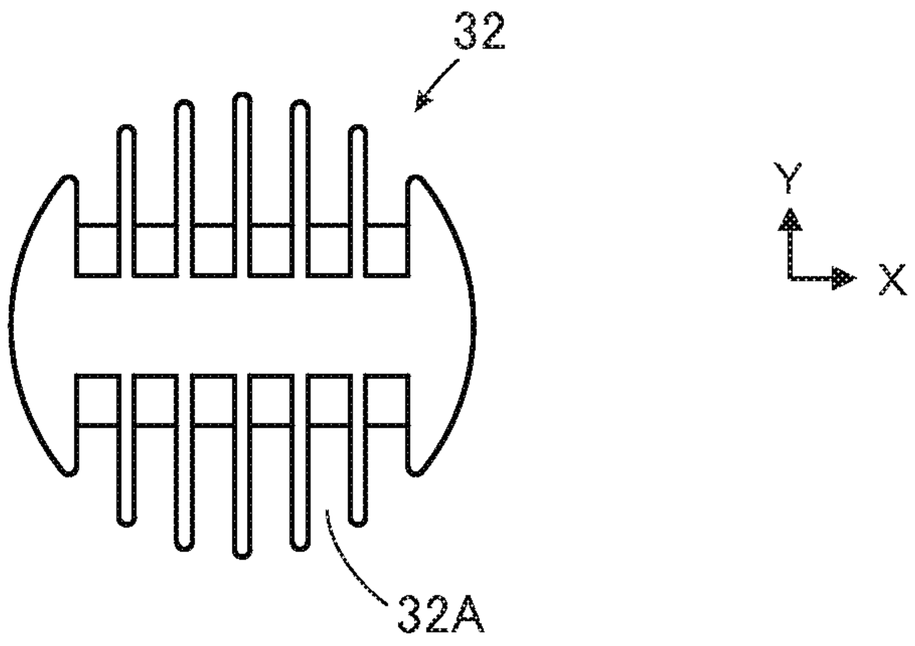


FIG. 22

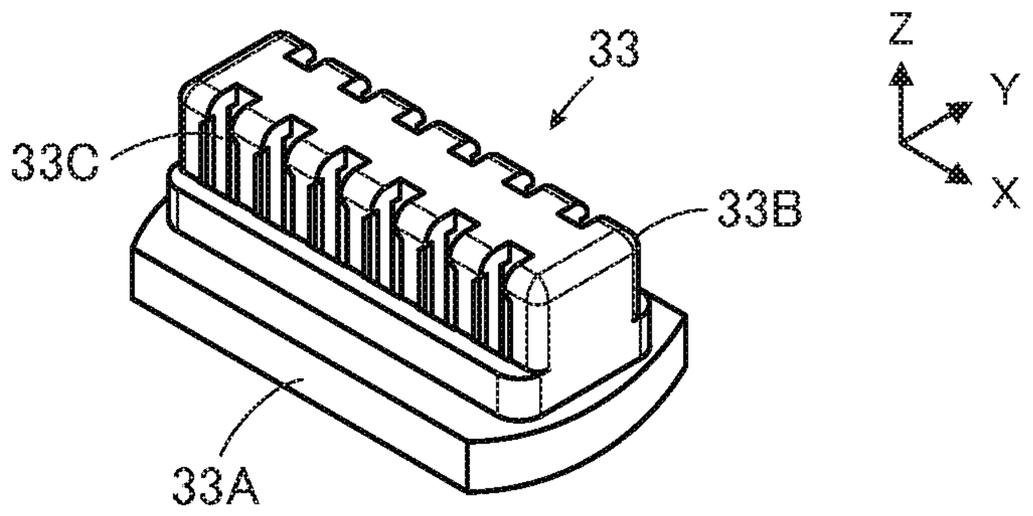


FIG. 23

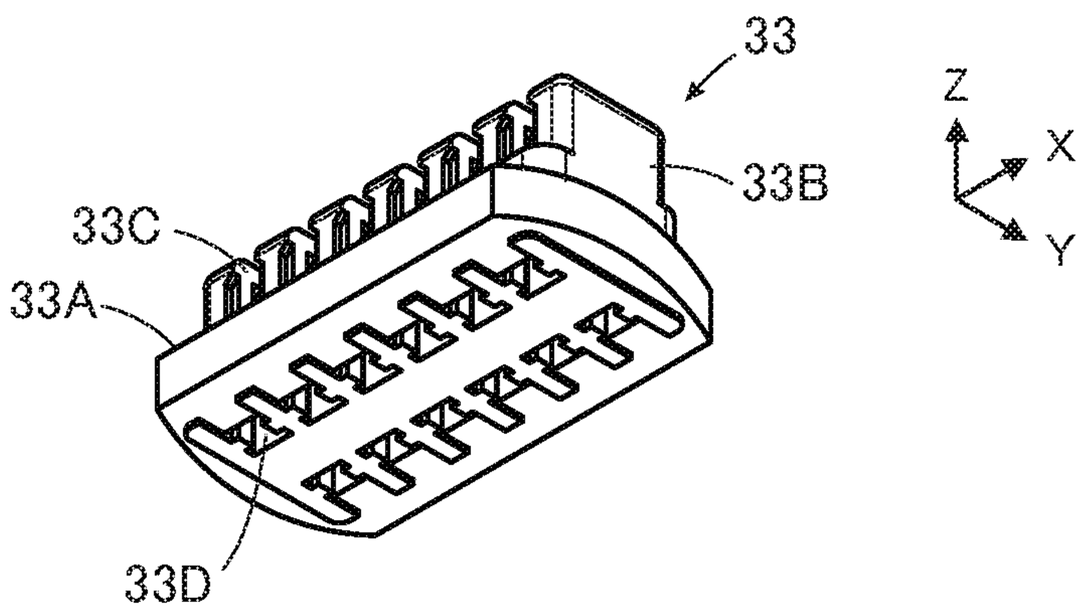


FIG. 24

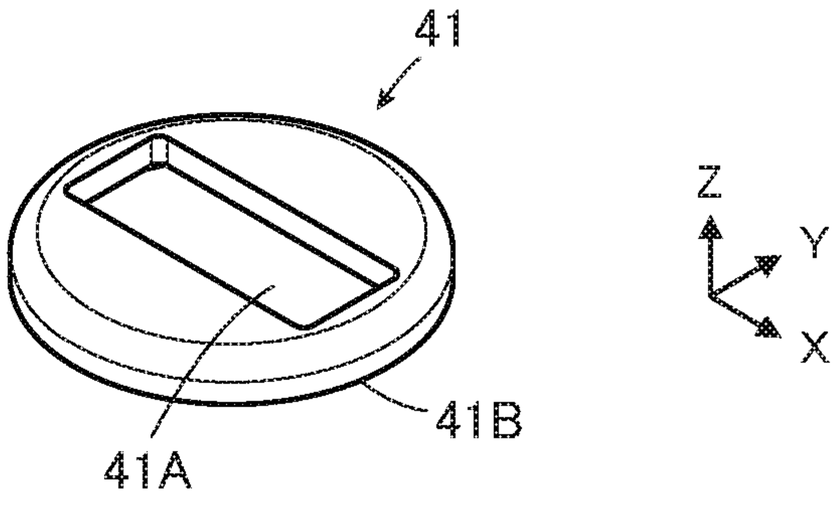


FIG. 25

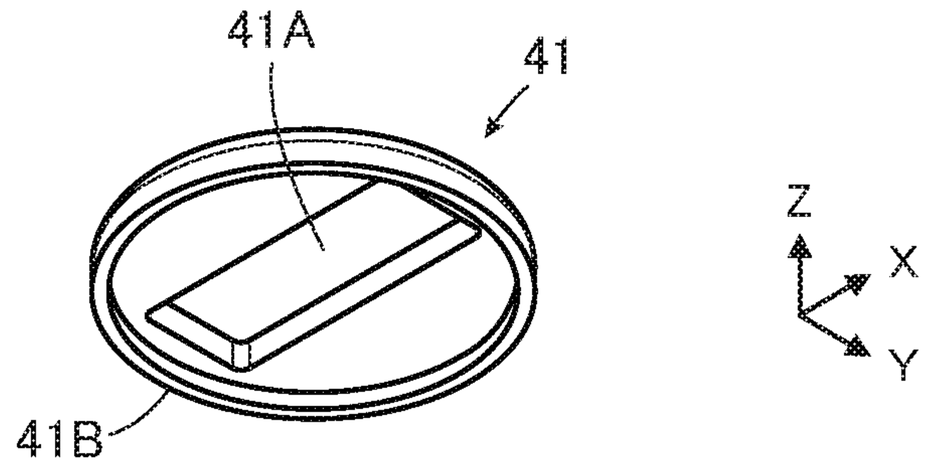


FIG. 26

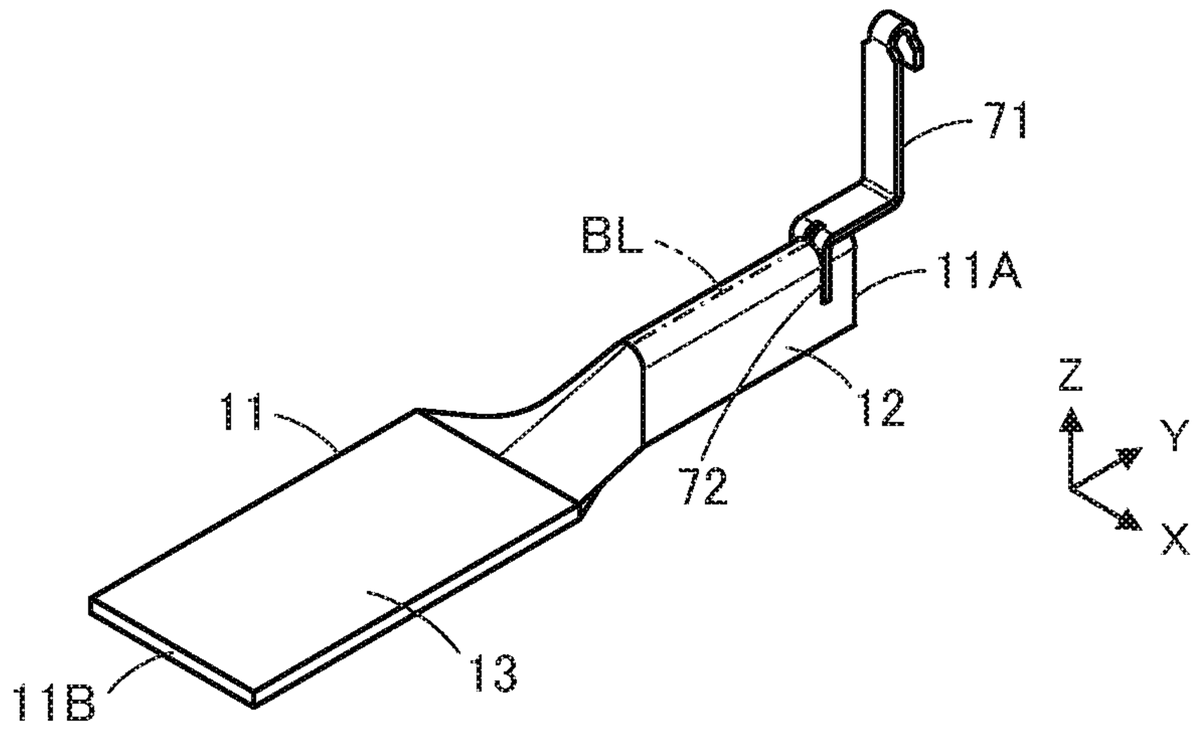


FIG. 27

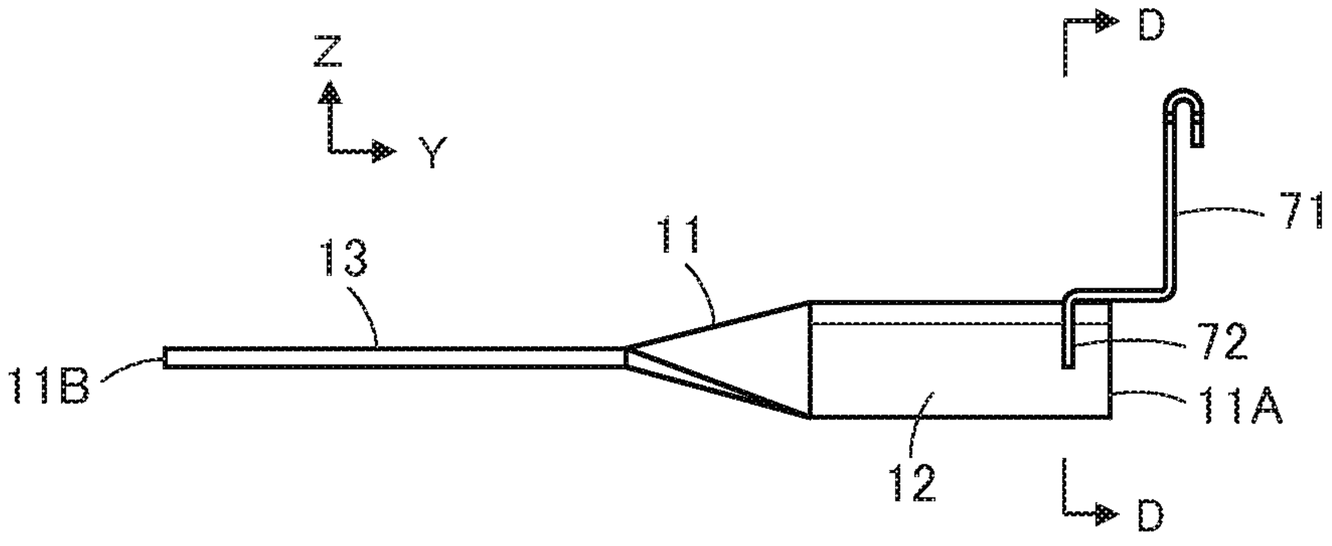


FIG. 28

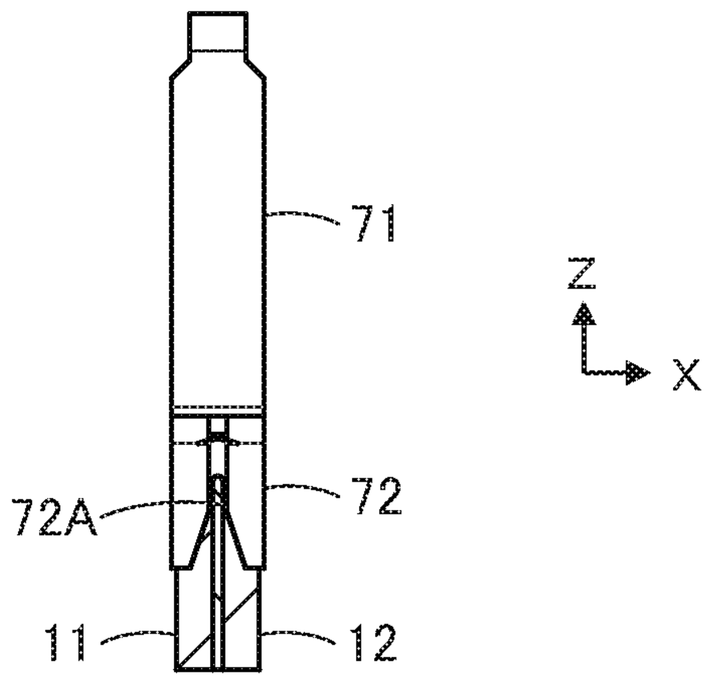


FIG. 29

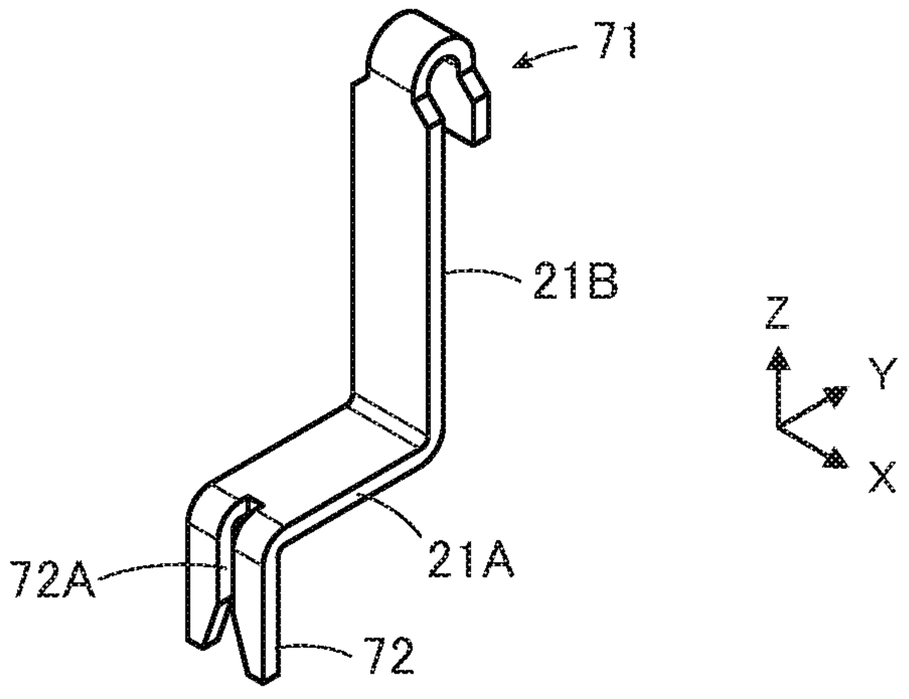


FIG. 30

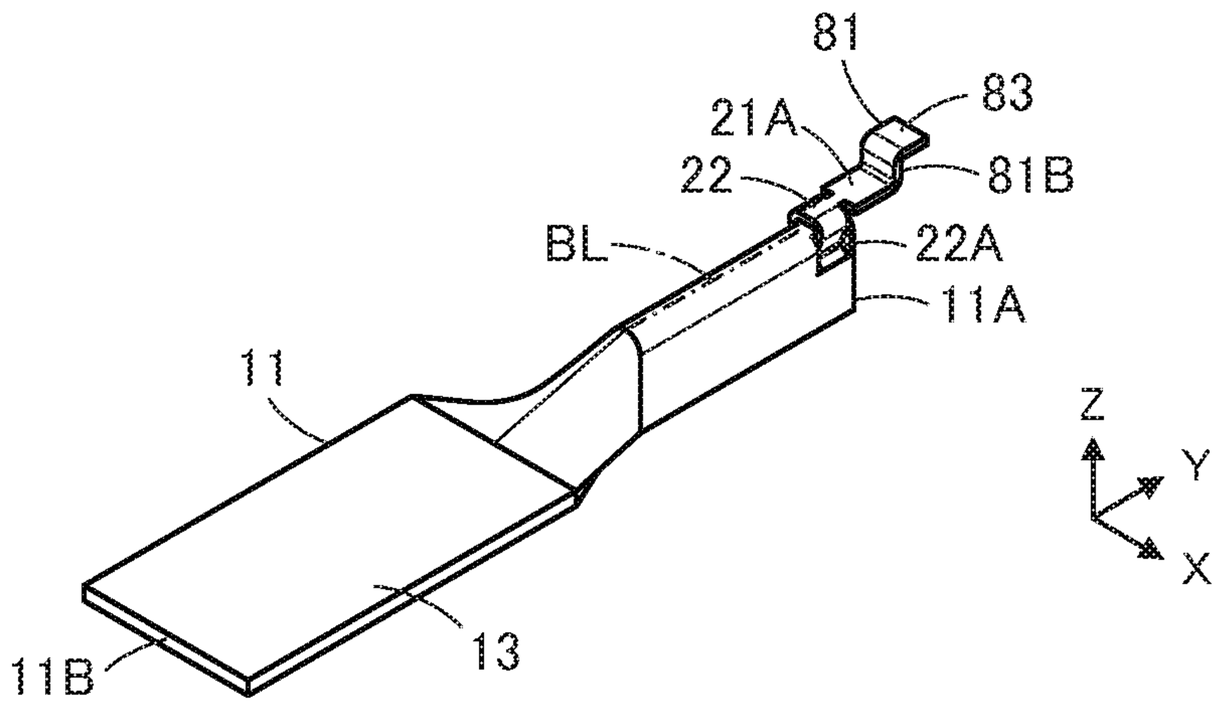
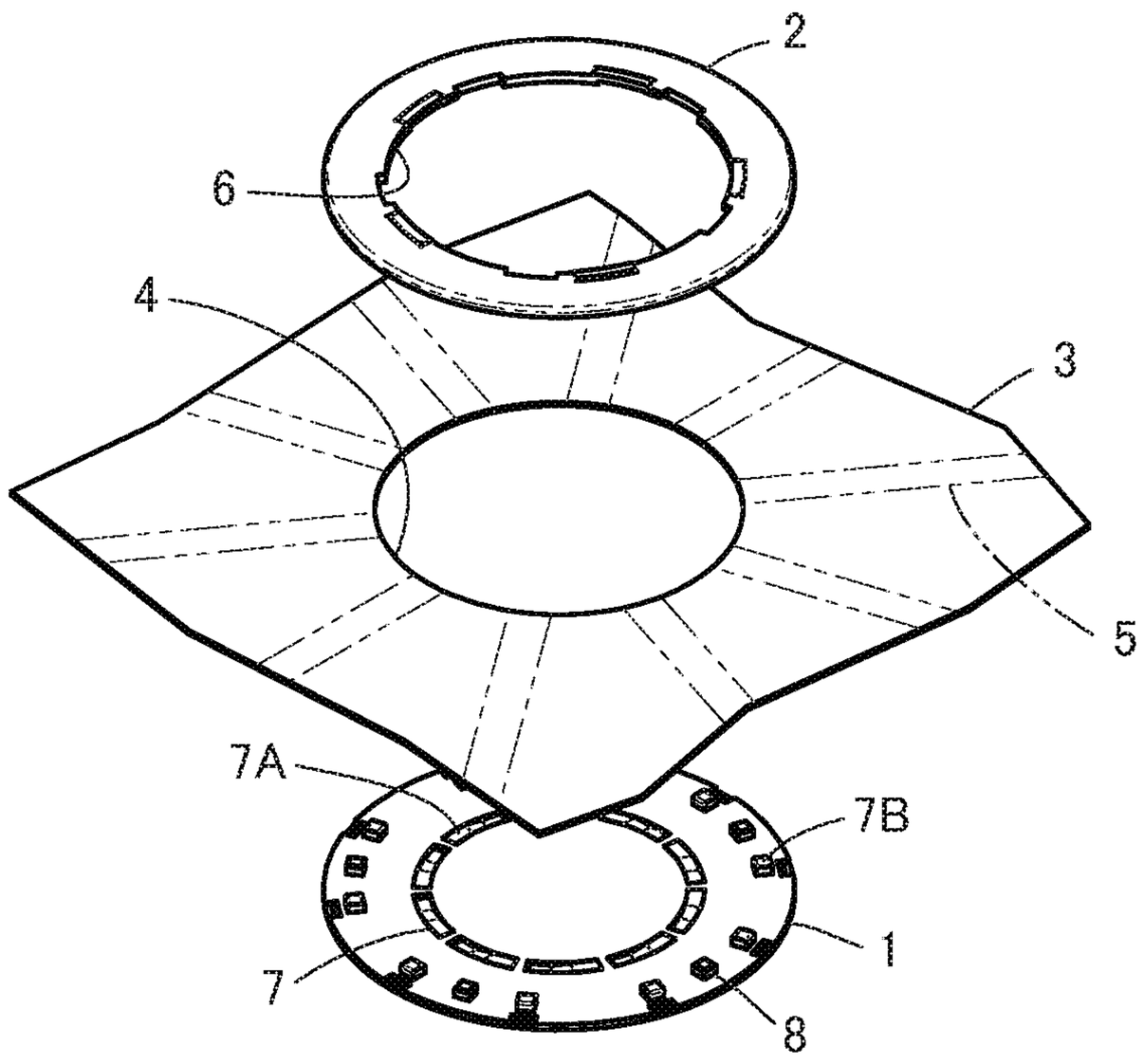


FIG. 31
PRIOR ART



CONNECTING METHOD, CONNECTING STRUCTURE, CONTACT AND CONNECTOR

BACKGROUND OF THE INVENTION

The present invention relates to a connecting method, in particular, to a connecting method for electrically connecting a contact having conductivity to a flexible conductor extending in a given direction.

The present invention also relates to a connecting structure, a contact and a connector.

As a structure of connecting a contact to a conductive portion of a flexible substrate, for example, JP2017-182897A discloses a connector as shown in FIG. **31**. The connector comprises a base member **1** in a circular disk shape and a frame member **2** in an annular shape, and cloth **3** of a garment is sandwiched from opposite sides by the base member **1** and the frame member **2**, whereby the connector is attached to the cloth **3**.

In the cloth **3**, a circular opening portion **4** is formed, and on the rear surface of the cloth **3**, a plurality of band-shaped conductive portions **5** are arranged radially about the opening portion **4**. The frame member **2** is also provided with a circular opening portion **6** having a substantially same size as that of the opening portion **4** in the cloth **3**.

The base member **1** holds a plurality of contacts **7**, and each of the contacts **7** is provided with a contact portion **7**A at one end thereof and an external connection portion **7**B at the other end thereof. Contact portions **7**A of the contacts **7** are exposed on the front surface of the base member **1** while being arranged in the circumferential direction to form a circle with a smaller diameter than those of the opening portion **4** of the cloth **3** and the opening portion **6** of the frame member **2**. External connection portions **7**B of the contacts **7** are exposed on and project from the front surface of the base member **1** in a vicinity of the outer periphery of the base member **1**.

In the vicinity of the outer periphery of the base member **1** on its front surface, a plurality of projections **8** are formed to project from the front surface of the base member **1**, whereas the rear surface of the frame member **2** is provided with a plurality of fitting holes (not shown) corresponding to the external connection portions **7**B of the contacts **7** and the projections **8**.

The front surface of the base member **1** is brought into contact with the rear surface of the cloth **3**, the base member **1** is aligned to the frame member **2**, and the rear surface of the frame member **2** is brought into contact with the front surface of the cloth **3** such that one end of each of the conductive portions **5** near the opening portion **4** of the cloth **3** comes into contact with the corresponding external connection portion **7**B of the base member **1**; in this state, the frame member **2** is firmly pressed to the base member **1**. Accordingly, the external connection portions **7**B and the projections **8** of the base member **1** are fitted in the corresponding fitting holes of the frame member **2**, with the cloth **3** being sandwiched therebetween, whereby the connector is attached to the cloth **3**.

In this process, the conductive portions **5** of the cloth **3** are pressed into the corresponding fitting holes of the frame member **2** while being in contact with the external connection portions **7**B of the corresponding contacts **7** of the base member **1** and are thus electrically connected to the contacts **7**.

Meanwhile, the external connection portions **7**B of the contacts **7** disposed in the vicinity of the outer periphery of the front surface of the base member **1** are connected to one

ends of the corresponding band-shaped conductive portions **5** that are radially arranged on the rear surface of the cloth **3**, resulting in a problem that the arrangement pitch of the contacts **7** becomes large.

Although it would be possible to reduce the arrangement pitch of the contacts **7** by reducing the width of the band-shaped conductive portions **5** that are arranged on the rear surface of the cloth **3**, it is required to ensure a certain width of the conductive portions **5** from the perspective of an amount of electrical conduction and conduction reliability, and therefore it has been difficult to configure a miniaturized connector.

In particular, since the conductive portions **5** comprising cloth conductors made of, for example, conductive fibers have the lower conductivity compared to a metallic conductor and have the smaller effective contact area compared to the occupancy area of the conductive portions **5** due to the uneven profile of its contact surface, the conductive portions **5** need to have a sufficient width, and therefore it is difficult to narrow the arrangement pitch of the contacts **7**.

SUMMARY OF THE INVENTION

The present invention has been made in order to solve the conventional problem described above and is aimed at providing a connecting method for electrically connecting a contact having conductivity to a flexible conductor while realizing a narrower arrangement pitch when a plurality of contacts are arranged.

The present invention also aims at providing a connecting structure obtained by use of the connecting method, as well as a contact and a connector for use in the connecting method.

A connecting method according to the present invention is a connecting method for electrically connecting a contact having conductivity to a flexible conductor extending in a given direction, the connecting method comprising:

forming a first connection portion at an end portion of the flexible conductor by folding the end portion of the flexible conductor in halves along a folding line extending in the given direction; and

pressing the first connection portion with a contact-side connection portion of the contact from opposite sides in a thickness direction of the first connection portion to thereby electrically connect the contact to the flexible conductor.

A connecting structure according to the present invention is a connecting structure in which a contact having conductivity is electrically connected to a flexible conductor extending in a given direction,

wherein the flexible conductor includes a first connection portion that is formed by folding an end portion of the flexible conductor in halves along a folding line extending in the give direction,

wherein the contact includes a contact-side connection portion, and

wherein the first connection portion is pressed with the contact-side connection portion from opposite sides in a thickness direction of the first connection portion to thereby electrically connect the contact to the flexible conductor.

A contact according to the present invention is a contact having conductivity that is to be electrically connected to a flexible conductor extending in a given direction, the contact comprising:

a contact-side connection portion to be connected to a first connection portion that is formed at an end portion of the

flexible conductor by folding the end portion of the flexible conductor in halves along a folding line extending in the given direction,

wherein the contact-side connection portion presses the first connection portion from opposite sides in a thickness direction of the first connection portion to be electrically connected to the flexible conductor.

A connector according to the present invention comprises:

a plurality of contacts having conductivity;

a plurality of flexible conductors connected to the plurality of contacts and each extending in a given direction; and

a housing for holding the plurality of contacts,

wherein each contact of the plurality of contacts includes:

a contact-side connection portion that is disposed at an end of the each contact and connected to a corresponding flexible conductor;

a contact portion that is disposed at another end of the each contact and comes into contact with a corresponding contact of a counter connector when the connector is fitted with the counter connector along a fitting axis; and

a holding portion that is disposed between the contact-side connection portion and the contact portion and is embedded in and held by the housing,

wherein each flexible conductor of the plurality of flexible conductors includes:

a first connection portion that is formed by folding an end portion lying in the given direction of the each flexible conductor in halves along a folding line extending in the given direction; and

a second connection portion that is disposed at another end portion in the given direction of the each flexible conductor, and

wherein the contact-side connection portion of the each contact presses the first connection portion of a corresponding flexible conductor from opposite sides in a thickness direction of the first connection portion, whereby the plurality of contacts are electrically connected to the plurality of flexible conductors.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view showing a connecting structure according to Embodiment 1.

FIG. **2** is a plan view showing the connecting structure according to Embodiment 1.

FIG. **3** is a side view showing the connecting structure according to Embodiment 1.

FIG. **4** is a cross-sectional view taken along line A-A in FIG. **3**.

FIG. **5** is a perspective view of a flexible conductor for use in the connecting structure of Embodiment 1 when viewed from an obliquely upper position.

FIG. **6** is a perspective view of the flexible conductor for use in the connecting structure of Embodiment 1 when viewed from an obliquely lower position.

FIG. **7** is a perspective view showing the flexible conductor for use in the connecting structure of Embodiment 1 with an end portion thereof being folded in halves.

FIG. **8** is a side view showing the flexible conductor for use in the connecting structure of Embodiment 1 with the end portion thereof being folded in halves.

FIG. **9** is a perspective view showing a contact for use in the connecting structure of Embodiment 1 in an unconnected state.

FIG. **10** is a perspective view showing the contact for use in the connecting structure of Embodiment 1 in a connected state.

FIG. **11** is a perspective view of a connector using the connecting structure of Embodiment 1 when viewed from an obliquely upper position.

FIG. **12** is a plan view showing the connector using the connecting structure of Embodiment 1.

FIG. **13** is a perspective view of the connector using the connecting structure of Embodiment 1 when viewed from an obliquely lower position.

FIG. **14** is a side view showing the connector using the connecting structure of Embodiment 1.

FIG. **15** is a perspective view of a plurality of connecting structures arranged in the connector when viewed from an obliquely upper position.

FIG. **16** is a plan view showing the plurality of connecting structures arranged in the connector.

FIG. **17** is a perspective view of the plurality of connecting structures arranged in the connector when viewed from an obliquely lower position.

FIG. **18** is a cross-sectional view taken along line B-B in FIG. **14**.

FIG. **19** is a cross-sectional view taken along line C-C in FIG. **14**.

FIG. **20** is a perspective view showing a lower insulator of a housing used in the connector.

FIG. **21** is a plan view showing the lower insulator of the housing used in the connector.

FIG. **22** is a perspective view of an upper insulator of the housing used in the connector when viewed from an obliquely upper position.

FIG. **23** is a perspective view of the upper insulator of the housing used in the connector when viewed from an obliquely lower position.

FIG. **24** is a perspective view of an exterior member used in the connector when viewed from an obliquely upper position.

FIG. **25** is a perspective view of the exterior member used in the connector when viewed from an obliquely lower position.

FIG. **26** is a perspective view showing a connecting structure according to Embodiment 2.

FIG. **27** is a side view showing the connecting structure according to Embodiment 2.

FIG. **28** is a cross-sectional view taken along line D-D in FIG. **27**.

FIG. **29** is a perspective view showing a contact for use in the connecting structure of Embodiment 2.

FIG. **30** is a perspective view showing a connecting structure according to Embodiment 3.

FIG. **31** is an exploded perspective view showing a conventional connector.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the present invention are described below based on the appended drawings.

Embodiment 1

FIGS. **1** to **3** illustrate a connecting structure according to Embodiment 1. In the connecting structure, a contact **21** having conductivity is connected to an end portion (tip portion) **11**A of a flexible conductor **11** extending in a given direction.

The flexible conductor **11** comprises conductive fibers formed into a band shape extending from the end portion **11**A to the other end portion **11**B, and a first connection

portion **12** is disposed at the end portion **11**A, while a second connection portion **13** is disposed at the other end portion **11**B. The first connection portion **12** is formed of the end portion **11**A of the flexible conductor **11** that is folded in halves along a folding line BL extending in the given direction. The second connection portion **13** disposed at the other end portion **11**B of the flexible conductor **11** is not folded in halves but planarly extends.

The contact **21** includes a contact-side connection portion **22** formed at one end of the contact **21**, and the first connection portion **12** of the flexible conductor **11** is pressed with the contact-side connection portion **22** from opposite sides in the thickness direction of the first connection portion **12**, whereby the contact **21** is electrically connected to the flexible conductor **11**.

For ease of understanding, a plane along which the other end portion **11**B of the flexible conductor **11** extends is called "XY plane," the given direction in which the flexible conductor **11** extends from the other end portion **11**B toward the end portion **11**A of the flexible conductor **11** "+Y direction," and a direction extending perpendicularly to the XY plane "Z direction."

The flexible conductor **11** is folded in halves along the folding line BL so that the resulting first connection portion **12** formed at the end portion **11**A of the flexible conductor **11** has a flat plate shape extending along the YZ plane. Accordingly, as illustrated in FIG. **2**, while the second connection portion **13** disposed at the other end portion **11**B of the flexible conductor **11** and planarly extending along the XY plane without being folded has a width W**2** in the X direction, the first connection portion **12** formed at the end portion **11**A of the flexible conductor **11** has a width W**1** in the X direction that is narrower than the width W**2** of the second connection portion **13**.

The contact-side connection portion **22** of the contact **21** includes a pair of nipping pieces **22**A independently disposed on the +X direction side and on the −X direction side of the first connection portion **12** of the flexible conductor **11**. As illustrated in FIG. **4**, the first connection portion **12** of the flexible conductor **11** is sandwiched between and pressed by the pair of nipping pieces **22**A from opposite sides in the X direction that is the thickness direction of the first connection portion **12**, so as to be in contact with the pair of nipping pieces **22**A while being compressed in the X direction.

Next, a method of manufacturing a connecting structure according to Embodiment 1 is described.

As illustrated in FIGS. **5** and **6**, at the end portion **11**A of the flexible conductor **11** comprising conductive fibers formed into a band shape extending in the Y direction, the folding line BL is defined to extend in the Y direction on the center line of the X directional width of the flexible conductor **11**. Here, the rear surface, facing the −Z direction, of the end portion **11**A of the flexible conductor **11** is coated with an adhesive **14**.

Then, the end portion **11**A of the flexible conductor **11** is folded in halves along the folding line BL such that the front surface, facing the +Z direction, of the flexible conductor **11** forms a convex shape, and halves of the rear surface of the flexible conductor **11** are superposed to face each other. The flexible conductor **11** made of conductive fibers have the fiber direction in the Y direction that coincides with the folding line BL, which helps the flexible conductor **11** to be readily folded. Since the rear surface of the end portion **11**A of the flexible conductor **11** is coated with the adhesive **14**, the halves of the rear surface are bonded together to form the first connection portion **12** in a flat plate shape extending along the YZ plane at the end portion **11**A of the flexible conductor **11**, as illustrated in FIGS. **7** and **8**.

The contact **21** is formed of a metal sheet that is bent into a substantially L shape and includes a first extension portion **21**A extending in the Y direction and a second extension portion **21**B extending from the +Y directional end of the first extension portion **21**A in the +Z direction, as illustrated in FIG. **9**. The contact-side connection portion **22** is disposed at the −Y directional end of the first extension portion **21**A, a contact portion **23** is disposed on the +Z direction side in the second extension portion **21**B, and a holding portion **24** is disposed between the contact-side connection portion **22** and the contact portion **23**.

The pair of nipping pieces **22**A of the contact-side connection portion **22** separately extend in opposite directions, i.e., in the +X direction and the −X direction.

The end portion of the contact portion **23** is bent into a U shape at the +Z directional end of the second extension portion **21**B.

While the contact **21** is aligned with respect to the flexible conductor **11** such that the contact-side connection portion **22** including the pair of nipping pieces **22**A that separately extend in opposite directions comes into contact with the +Y directional end of the first connection portion **12** of the flexible conductor **11** at the edge of the first connection portion **12** on the +Z direction side, the pair of nipping pieces **22**A are bent in the −Z direction to nip the first connection portion **12** as illustrated in FIG. **10** to press the first connection portion **12** from opposite sides in the thickness direction of the first connection portion **12** that is the X direction. Accordingly, the connecting structure in which the contact **21** is electrically connected to the flexible conductor **11** as illustrated in FIGS. **1** to **4** is obtained.

Since the flexible conductor **11** is connected to the contact **21** in such a manner that the end portion **11**A of the flexible conductor **11** is folded in halves along the folding line BL to form the first connection portion **12** in a flat plate shape extending along the YZ plane and that the contact-side connection portion **22** of the contact **21** presses the first connection portion **12** from opposite sides in the thickness direction of the first connection portion **12** that is the X direction, the occupancy area of the first connection portion **12** as viewed from the Z direction can be reduced, while the effective contact area between the flexible conductor **11** and the contact **21** can be secured.

FIGS. **11** to **14** illustrate a connector that is configured using the connecting structure according to Embodiment 1. The connector is to be fitted with a counter connector that is not shown along a fitting axis C**1** extending in the Z direction and includes a plurality of contacts **21** arranged in the X direction in two rows and a housing **31** for holding the contacts **21**. In each row, the contacts **21** are arranged in the X direction that is orthogonal to the fitting axis C**1** at an arrangement pitch P. To the contacts **21**, independently connected are a plurality of flexible conductors **11** that are arranged substantially radially about the fitting axis C**1** within the XY plane that is perpendicular to the fitting axis C**1**. Each of the contacts **21** is connected to the corresponding flexible conductor **11** by means of the connecting structure as shown in FIGS. **1** to **4**.

A value of the arrangement pitch P of the contacts **21** is set such that the arrangement pitch P is wider than the width W**1** of each of the first connection portions **12** of the flexible conductors **11** and narrower than the width W**2** of each of the second connection portions **13** of the flexible conductors **11** when viewed in the direction along the fitting axis C**1**.

In addition, the connector includes an exterior member **41** covering the periphery of the housing **31** from the +Z direction, a circular upper cover **51** entirely covering the radially-arranged flexible conductors **11** from the +Z direction, and a circular lower cover **61** covering the first connection portions **12** of the radially-arranged flexible conductors **11** from the −Z direction.

The housing **31** and the exterior member **41** are made of an insulating resin, while the upper cover **51** and the lower cover **61** are made of flexible insulating fibers or a flexible insulating resin film.

The lower cover **61** has a diameter smaller than that of the upper cover **51**, and as illustrated in FIG. **13**, the second connection portions **13** disposed at the other end portions **11**B of the flexible conductors **11** are not covered by the lower cover **61** but are exposed. The upper cover **51** and the lower cover **61** together constitute a cover member that covers the first connection portions **12** of the flexible conductors **11** but allows the second connection portions **13** of the flexible conductors **11** to be exposed.

FIGS. **15** to **17** illustrate only a plurality of connecting structures that are arranged in the connector, where illustration of the housing **31**, the exterior member **41**, the upper cover **51** and the lower cover **61** of the connector shown in FIGS. **11** to **13** is omitted. In each connecting structure, the contact-side connection portion **22** of the contact **21** is connected to the first connection portion **12** of the corresponding flexible conductor **11**. While the contacts **21** are arranged in the X direction in two rows, the first connection portions **12** of the flexible conductors **11** connected to the contacts **21** are each bent within the XY plane so that the second connection portions **13** of the flexible conductors **11** are arranged in a circumferential direction so as to form a substantially circular shape about the fitting axis C**1** within the XY plane that is perpendicular to the fitting axis C**1**.

As illustrated in FIGS. **18** and **19**, the housing **31** comprises a lower insulator **32** and an upper insulator **33** that is disposed on the lower insulator **32**.

The first connection portions **12** of the flexible conductors **11**, to which the contact-side connection portions **22** of the corresponding contacts **21** are separately connected, are held by the lower insulator **32**, and the second extension portions **21**B of the contacts **21** are held by the upper insulator **33**.

As illustrated in FIGS. **20** and **21**, the lower insulator **32** has a circular disk shape extending along the XY plane, and a part of the lower insulator **32** on the +Y direction side and another part on the −Y direction side are each provided with a plurality of slots **32**A extending in the Y direction and arranged in the X direction at equal intervals. The slots **32**A are for receiving and holding the first connection portions **12** of the flexible conductors **11**.

As illustrated in FIGS. **22** and **23**, the upper insulator **33** includes a base portion **33**A in a flat plate shape extending along the XY plane and a projection portion **33**B in a substantially cuboid shape projecting from the base portion **33**A in the +Z direction and extending in the X direction. A part of the projection portion **33**B on the +Y direction side and another part on the −Y direction side are each provided with a plurality of contact-holding grooves **33**C extending in the Z direction, and the base portion **33**A is provided with a plurality of through holes **33**D independently communicating with the contact-holding grooves **33**C of the projection portion **33**B. The contact-holding grooves **33**C and the through holes **33**D are for holding the second extension portions **21**B of the contacts **21**.

The contact-holding grooves **33**C and the through holes **33**D are provided in the upper insulator **33** so as to independently correspond to the slots **32**A of the lower insulator **32**. In other words, the upper insulator **33** and the lower insulator **32** are configured such that, when the upper insulator **33** is disposed on the lower insulator **32**, the slots **32**A of the lower insulator **32** independently communicate with the corresponding through holes **33**D and the corresponding contact-holding grooves **33**C of the upper insulator **33**.

As illustrated in FIGS. **24** and **25**, the exterior member **41** covering the periphery of the housing **31** from the +Z direction has a circular disk shape extending along the XY plane and is provided at the center part thereof with a rectangular opening portion **41**A extending in the X direction and at the outer periphery thereof with an annular projection **41**B projecting in the −Z direction. The opening portion **41**A has a size that allows the projection portion **33**B of the upper insulator **33** of the housing **31** to be inserted therethrough.

With the contacts **21** independently connected to the corresponding flexible conductors **11** being arranged in the X direction in two rows as illustrated in FIGS. **15** to **17**, the upper insulator **33** can be formed integrally with the contacts **21** using a mold that is not shown. The holding portion **24** of each contact **21** is placed in the corresponding through hole **33**D in the upper insulator **33**, and the contact portion **23** is held in the corresponding contact-holding groove **33**C of the upper insulator **33** and is exposed outward from the projection portion **33**B of the upper insulator **33**.

The lower insulator **32** preliminarily formed by molding an insulating resin is moved from the −Z direction toward the +Z direction until the lower insulator **32** comes into contact with the surface of the upper insulator **33** on the −Z direction side, and the first connection portions **12** of the flexible conductors **11** connected to the contact-side connection portions **22** of the contacts **21** are independently inserted into the corresponding slots **32**A of the lower insulator **32**, whereby the housing **31** holding the contacts **21** is formed.

Subsequently, as illustrated in FIGS. **18** and **19**, all the flexible conductors **11** extending substantially radially about the fitting axis C**1** are covered by the circular upper cover **51** from the +Z direction, the first connection portions **12** of the flexible conductors **11** are covered by the circular lower cover **61** from the −Z direction, and the exterior member **41** is placed on the upper cover **51** from the +Z direction, while the projection portion **33**B of the upper insulator **33** projects from the opening portion **41**A of the exterior member **41** in the +Z direction.

At the center of the upper cover **51**, an opening portion **51**A to receive the base portion **33**A of the upper insulator **33** is formed, and the upper cover **51** is disposed over the lower insulator **32**, the first extension portions **21**A of the contacts **21** and the flexible conductors **11**, while the exterior member **41** is disposed over the base portion **33**A of the upper insulator **33** and the upper cover **51**. In addition, the lower cover **61** is disposed on the −Z direction side of the lower insulator **32** and the first connection portions **12** of the flexible conductors **11**.

The connector as illustrated in FIGS. **11** to **14** is manufactured in this manner.

The connecting structure used in the connector manufactured in this manner connects the flexible conductor **11** to the contact **21** by pressing the first connection portion **12** in a flat plate shape that is formed by folding the end portion **11**A of the flexible conductor **11** in halves along the folding line BL, from opposite sides in the thickness direction of the first connection portion **12**, with the contact-side connection

portion **22** of the contact **21** as illustrated in FIGS. **1** to **3**. Accordingly, when the plurality of contacts **21** independently connected to the corresponding flexible conductors **11** are arranged in a direction orthogonal to the fitting axis C**1** so that the flexible conductors **11** are arranged substantially radially about the fitting axis C**1** within a plane perpendicular to the fitting axis C**1**, the arrangement pitch P of the contacts **21** can be narrower than the width W**2** of the second connection portion **13** of each flexible conductor **11**, thus enabling to narrow the arrangement pitch of the contacts **21**.

The connector shown in FIGS. **11** to **14** can be used, for example, as a connector for a so-called wearable device when the connector is attached to a garment and the second connection portions **13** of the flexible conductors **11** are electrically connected to a plurality of conductive members provided on the garment.

While the halves of the rear surface of the flexible conductor **11** that is folded along the folding line BL are bonded together with the adhesive **14** coated on the rear surface of the end portion **11**A of the flexible conductor **11**, the adhesive **14** may be replaced by, for example, a double-sided adhesive tape to bond the halves of the rear surface together.

Although the folded halves of the rear surface of the flexible conductor **11** need not be bonded together, it is preferable that the halves of the rear surface of the flexible conductor **11** are bonded together in order to prevent the first connection portions **12** of neighboring flexible conductors **11** from short-circuiting when the contacts **21** independently connected to the corresponding flexible conductors **11** are arranged at the arrangement pitch P.

The upper insulator **33** of the housing **31** is integrally formed with the plurality of contacts **21**, but this is not the sole case. Also, by pressing the contacts **21** into the upper insulator **33** that has been preliminarily formed by molding an insulating resin, the configuration where the plurality of contacts **21** are held by the upper insulator **33** can be realized.

To the contacts **21** that have been incorporated into the upper insulator **33**, the first connection portions **12** of the flexible conductors **11** independently corresponding to the contact-side connection portions **22** of the contacts **21** may be connected.

Embodiment 2

FIGS. **26** to **28** illustrate a connecting structure according to Embodiment 2. In the connecting structure, the first connection portion **12** of the flexible conductor **11** used in Embodiment 1 is connected to a contact **71** having conductivity.

The contact **71** includes a contact-side connection portion **72** formed at one end of the contact **71**, and the first connection portion **12** of the flexible conductor **11** is inserted into a slit **72**A formed in the contact-side connection portion **72**, whereby the contact **71** is electrically connected to the flexible conductor **11**.

As illustrated in FIG. **29**, the contact **71** is provided with, in place of the contact-side connection portion **22** of the contact **21** used in Embodiment 1, the contact-side connection portion **72** at the −Y directional end of the first extension portion **21**A and otherwise has the same configuration as that of the contact **21**.

The contact-side connection portion **72** bends from the −Y directional end of the first extension portion **21**A toward the −Z direction to extend in the Z direction, and the slit **72**A is formed from the −Z directional end of the contact-side connection portion **72** and extends in the Z direction.

When the first connection portion **12** of the flexible conductor **11** is inserted into the slit **72**A, the first connection portion **12** is pressed with the inner faces of the slit **72**A from opposite sides in the thickness direction of the first connection portion **12** that is the X direction, whereby the flexible conductor **11** and the contact **71** are electrically connected to each other.

With use of the connecting structure of Embodiment 2, it is also possible to narrow the arrangement pitch of a plurality of contacts **71** in the same manner as in Embodiment 1.

Embodiment 3

FIG. **30** illustrates a connecting structure according to Embodiment 3. In the connecting structure of Embodiment 3, the first connection portion **12** of the flexible conductor **11** used in Embodiment 1 is connected to a contact **81** having conductivity.

The contact **81** includes, in place of the second extension portion **21**B of the contact **21** used in Embodiment 1, a second extension portion **81**B having a shorter length in the Z direction than that of the second extension portion **21**B, which second extension portion **81**B is joined to the +Y directional end of the first extension portion **21**A, and otherwise has the same configuration as that of the contact **21**.

The +Z directional end of the second extension portion **81**B bends toward the +Y direction and is provided with a planar contact portion **83** facing the +Z direction. The contact portion **83** is to be connected to a conductive portion of a circuit board (not shown) that extends along the XY plane on the +Z direction side of the contact **81** through soldering, for example.

With use of the connecting structure of Embodiment 3, the flexible conductor **11** can be connected to a circuit board and, at the same time, it is possible to narrow the arrangement pitch of a plurality of contacts **81** in the same manner as in Embodiment 1.

Note that the contact **81** achieves electrical connection with the flexible conductor **11** by pressing the pair of nipping pieces **22**A of the contact-side connection portion **22** against the first connection portion **12** of the flexible conductor **11** from opposite sides in the thickness direction of the first connection portion **12** that is the X direction, as with the contact **21** used in Embodiment 1. In the meantime, the contact **81** may include, in place of the contact-side connection portion **22**, the contact-side connection portion **72** having the slit **72**A as with the contact **71** in Embodiment 2. Also with such configuration, the flexible conductor **11** can be connected to a circuit board, and at the same time, it is possible to narrow the arrangement pitch of a plurality of contacts **81**.

Moreover, the shape of the contact portion **83** of the contact **81** is not limited to that illustrated in FIG. **30** and can take on a variety of shapes.

What is claimed is:

1. A connector comprising:

a plurality of contacts having conductivity;

a plurality of flexible conductors connected to the plurality of contacts and each extending in a given direction; and

a housing for holding the plurality of contacts,

wherein each contact of the plurality of contacts includes:

a contact-side connection portion that is disposed at an end of the each contact and connected to a corresponding flexible conductor;

a contact portion that is disposed at another end of the each contact and comes into contact with a corresponding contact of a counter connector when the connector is fitted with the counter connector along a fitting axis; and

a holding portion that is disposed between the contact-side connection portion and the contact portion and is embedded in and held by the housing,

wherein each flexible conductor of the plurality of flexible conductors includes:

a first connection portion that is formed by folding an end portion lying in the given direction of the each flexible conductor in halves along a folding line extending in the given direction; and

a second connection portion that is disposed at another end portion in the given direction of the each flexible conductor, and

wherein the contact-side connection portion of the each contact presses the first connection portion of a corresponding flexible conductor from opposite sides in a thickness direction of the first connection portion, whereby the plurality of contacts are electrically connected to the plurality of flexible conductors,

wherein the plurality of conductive contacts are arranged in a direction orthogonal to the fitting axis,

wherein the plurality of flexible conductors extend substantially radially about the fitting axis within a plane perpendicular to the fitting axis such that the second connection portions of the plurality of flexible conductors are arranged in a circumferential direction to form a substantially circular shape about the fitting axis within the plane perpendicular to the fitting axis,

wherein the first connection portion of the each flexible conductor has a width W1 that is narrower than a width W2 of a corresponding second connection portion when viewed from a direction along the fitting axis,

wherein an arrangement pitch P of the plurality of contacts is wider than the width W1 of the first connection portion of the each flexible conductor and narrower than the width W2 of the second connection portion of the each flexible conductor when viewed from the direction along the fitting axis.

2. The connector according to claim **1**,

wherein the second connection portions of the plurality of flexible conductors are aligned in a circumferential direction about the fitting axis within the plane perpendicular to the fitting axis.

3. The connector according to claim **1**, wherein the plurality of flexible conductors are made of conductive fibers.

4. The connector according to claim **1**, further comprising a cover member covering the first connection portion of the each flexible conductor that is connected to the contact-side connection portion of the each contact while allowing the second connection portion of the each flexible conductor to be exposed.

5. The connector according to claim **1**,

wherein the first connection portion is formed by folding the end portion lying in the given direction of the each flexible conductor in halves along the folding line extending in the given direction such that the halves of a rear surface of the flexible conductor are superposed to face each other.

6. The connector according to claim **1**,

wherein the halves of the end portion of the flexible conductor folded along the folding line are bonded together to form the first connection portion.

7. The connector according to claim **1**,

wherein the contact is formed of a metal sheet,

wherein the contact-side connection portion includes a pair of nipping pieces separately extending in opposite directions, and

wherein the pair of nipping pieces are bent to sandwich the first connection portion from opposite sides in a thickness direction of the first connection portion to thereby electrically connect the contact to the first connection portion.

8. The connector according to claim **1**,

wherein the contact is formed of a metal sheet,

wherein the contact-side connection portion includes a slit, and

wherein the first connection portion is inserted into the slit to thereby electrically connect the contact to the first connection portion.

* * * * *